RESEARCH HIGHLIGHT

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# DRY AND COMFORTABLE FLOORS IN EXISTING BASEMENTS

## INTRODUCTION

Existing basements have different finish levels. Some may have plain concrete walls and floors and are not insulated. Others are completely finished living spaces, including bedrooms, bathrooms and family rooms, with the same comfort and refinement as above-grade rooms.

Many homeowners consider finishing their basements to create more living space. However, existing basements have a major problem—they are underground and more susceptible to water leakage and water migration. CMHC studies show that in various parts of Canada up to half the basements surveyed have signs of moisture entry or damage from high humidity.[1] Creating a living space in a damp environment can lead to building material degradation and health problems.

While there has been some research on basement wall assemblies that withstand moisture,[2] there is little work available about what flooring works well on concrete slabs. This CMHC research project looked at the options for finishing basement floors and their suitability for possible moisture problems.

## THE RESEARCH

The researchers surveyed literature about options for finishing basement floor slabs in existing houses. Since many basements have significant, pre-existing moisture problems, which preclude some options from consideration, the project looked at two specific conditions:

1. No observable basement water-leakage problems, but the possibility of condensation in spring and summer.
2. The possibility of incidental water leakage, sporadic water leakage or moisture movement—or all three—through the floor slab.

   If the basement floor receives no incidental water from wall or floor leakage, or capillary action, then it is assumed that any flooring option is permissible. If the basement has an existing water problem that can only be solved by major excavation within the basement or around the foundation, this situation is beyond the scope of the project.

## THE RESULTS

The following summarizes flooring options.

### Cleanable and disposable coverings

This includes conventional carpets and sheet coverings, which are not intended for permanent installation. They can be used if the homeowner recognizes that they may have to be periodically removed and cleaned or discarded if there is a major wetting event.

### Conventional area coverings

This includes conventional carpets and sheet coverings, which are intended for permanent installation in the basement. They cannot be easily removed for cleaning and are best when there is a high degree of confidence that the basement will remain dry.

[1] CMHC 1996. *Molds in finished basements*. Scanada Consultants Ltd. for CMHC, 1996.

[2] Building Science Corporation, 2004. *Basement insulation systems* English only, retrieved Septem-ber, 2004 from http://www.buildingscience.com/resources/foundations/ basement_insulation_systems.pdf
CMHC 1999. *Basement walls that dry*. University of Alberta for CMHC, 1999.

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### Built-up, non-insulated floor systems

In many cases, the existing floor slab cannot be used as the base for a finished floor system because of serious moisture problems or because the floor is cracked, uneven or in generally poor condition. In these cases, a new, built-up floor system can be built on top of the original slab to provide (in theory) a level, dry working surface on which to apply the finished floor. A typical built-up floor system consists of:

- a finished floor (any type can be used);
- a subfloor, typically plywood or OSB;
- furring or wooden sleepers, which either support or level the subfloor; and
- a polyethylene sheet, which functions as a moisture and vapour barrier.

### Built-up, insulated floor systems

Similar to built-up, non-insulated floor systems, but with a layer of insulation as part of the floor system to reduce heat loss and raise the floor's surface temperature, resulting in improved comfort and condensation resistance.

### Drainage mats and new subfloor

This built-up floor uses a drainage mat (sometimes called an "air-gap membrane") underneath a new subfloor. There are two alternatives: pre-manufactured panels, now commercially available in nominal 600 mm x 600 mm (2 ft. x 2 ft.) sizes, and site-constructed drainage floors created from rolls of drainage mat.

## THREE PROBLEMS DEFINED

The research identified three sets of moisture problems, along with the options available for finishing the floor slab. These problems and the appropriate flooring assemblies are listed below.

### Minor moisture problems

This is the mildest form of basement floor wetting. The condition exists when there are no overt basement water-leakage problems, although spring and summer condensation may exist on the floor or on other locations in the basement when the indoor relative humidity is high and portions of the basement floor (or other parts of basement) are below the dew point. Minor moisture problems are the least destructive type of basement floor wetting.

### Moderate moisture problems

This is a more pronounced situation. Wetting occurs mainly due to capillary action through the floor slab, although there may also be some condensation. If a floor exposed to moderate moisture threats can be sealed, then the same list of floor options shown for minor moisture problems can be used.

### Major moisture problems

This is a more extreme condition that occurs when moisture transport takes place by water leakage (bulk transport) and possibly by capillary action through the slab. There may also be condensation. If the floor is exposed to major moisture threats and if the water table can be lowered, then the same list of floor options shown for minor moisture problems can be used.

**Table 1—Summary of flooring options based on moisture threat**

| Existing moisture threat | Flooring options |
|---|---|
| **Minor problems** | Use Option List A |
| **Moderate problems** | • Seal basement floor.<br>• Re-test for capillary movement with the *Polyethylene Patch Test*<br>• If sealing works, then use Option List A.<br>• If sealing does not work, then use Option List B. |
| **Major problems** | • Lower water table to below level of existing floor surface.<br>• Re-test for bulk water movement using Standing *Water Test*.<br>• If floor passes Standing *Water Test*, use Option List A.<br>• If floor does not pass Standing *Water Test*, use Option List B. |

| Acceptable floor system options | |
|---|---|
| **Option list A** | **Option list B** |
| • Paints and coatings<br>• Cleanable and disposable coverings<br>• Conventional area coverings<br>• Built-up floor systems; non-insulated<br>• Built-up floor systems; insulated*<br>• Drainage mats and new subfloor* | • Paints and coatings<br>• Built-up floor systems; non-insulated*<br>• Built-up floor systems; insulated*<br>• Drainage mats and new subfloor* |
| * If major moisture problems are known to exist, the use of a blower (which exhausts to the outdoors) to mechanically depressurize the space below the subfloor should be included | |

## TESTING FOR WATER

### Polyethylene patch test

This test determines whether moisture is moving through the existing floor slab by capillary action.

Pieces of clear sheet polyethylene, approximately 600 mm x 600 mm (2 ft. x 2 ft.), are laid on top of the slab. The perimeter of the polyethylene is then sealed to the floor, using duct tape or other suitable material. The patches are left in place for at least two to three days.

If at the end of the exposure period there are no damp spots visible on the underside (floor side) of the polyethylene, then it can be assumed that moisture is not moving through the slab by capillary action—at least during the test period. If there is condensation on the top (house-side) of the polyethylene, then it is originating from internal (house) sources.

It is worth noting that a basement floor may appear to be dry even if moisture is moving upwards through the slab, since the moisture is able to evaporate into the interior air space as fast as it is transported through the slab. When an impermeable membrane is installed over a slab (such as with the polyethylene patch test), water is able to accumulate on the surface of the slab, under the polyethylene.

Preferably, two to five patches should be used, each on a different section of the slab. Portions of the slab that are not being considered for the new floor system can be ignored. To complement the polyethylene patch test, the slab can be examined for efflorescence. Since efflorescence can only develop when a significant amount of liquid water has been transported through the slab due to capillary action, the presence of efflorescence can be treated as an indication that there is capillary movement.

### Standing water test

This test determines whether moisture is moving through the slab due to bulk transport, that is, water leakage. Observations are made of all areas of the slab that have wet areas to determine if there is standing water present in the damp areas. When concrete gets wet, its appearance changes and it becomes darker with sheen on the surface (similar to that of a clay flower pot when it gets wet).

Slab wetting can occur by capillary action, water leakage from below or water drainage from above (for example, by leakage through the basement walls, which results in water accumulating on the slab). However, capillary action is not capable of transporting sufficient quantities of water to the surface of the slab for standing water. Therefore, the presence of standing water indicates the slab is saturated (at least in the affected area) and that an additional moisture transport mechanism is at work (water leakage from below or above).

One caution with this test is that standing water that originates from leakage through the basement walls (which ultimately ponds on the floor) should not be interpreted as a test failure, since the source of the water is not through the slab. However, wall leaks should be repaired at the earliest opportunity, not just to protect the new, finished floor surface but also to protect the interior, insulated portion of the basement wall. This is particularly important for controlling mold growth, since airborne mold spores are able to move from the insulated basement wall into the occupied portion of the basement and house.

Once again, it is critical to know as much as possible about the history of the house. If it has recently been purchased, it is highly recommended that discussions be held with the previous occupants to access their knowledge of the floor system's history.

The most discouraging finding of this research is that there is very little good data on flooring options and their performance in wet environments. The results provided are based in part on building science, moisture modelling, anecdotal evidence, manufacturers' recommendations and good practice. For instance, there is little-to-no research comparing the performance of hardwood floors to laminate floors following a short flooding event, or the moisture conditions under a polyethylene sheet beneath a carpet.

## IMPLICATIONS FOR RENOVATORS AND CONSUMERS

Dry basements, especially those with the slabs insulated underneath, can be finished in almost any manner without risk. Basement floors that suffer wetting, either from summer condensation, moisture movement through the concrete or sporadic leakage, are harder to finish. Water will damage the surfaces and promote the growth of mold.

The least-expensive, safest floor finishes for wet basements are bare concrete or painted concrete. There are alternatives that can be used judiciously, but the possibility for moisture retention and mold growth remains. Some systems may have moderately better resistance to wet conditions, however there is little good research to prove their effectiveness.

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